

Passive Radiation Shielding: Integrating Multilayer and Multipurpose Materials into Space Habitat Design

Completed Technology Project (2016 - 2020)



Project Introduction

The prospect of long-term human spaceflight beyond low Earth orbit poses a unique set of challenges for space habitat designers. One of those challenges is protecting astronauts from the ionizing radiation in space. On Earth, people are largely protected from that radiation by the atmosphere and the magnetic field. But beyond the natural protection mechanisms of the Earth, the space radiation environment can be dangerous for astronauts. It puts them at risk of several severe health problems, including cancer, central nervous system damage, and cataracts. Although there are several sources of ionizing radiation in space, one of the greatest causes for concern are galactic cosmic rays (GCRs). GCRs are isotropic and low in flux. They are a source of chronic radiation exposure, putting astronaut health at risk gradually over time. GCRs are mostly composed of protons and helium nuclei, but the largest concern for human health comes from their minority heavy ion component. The heavy ions in GCRs can potentially penetrate shielding and human tissue. In the interest of enabling a long-term lunar or Martian mission, the radiation protection systems should be improved to better protect against GCRs. One radiation protection method is passive shielding. A passive radiation shield is a material that is placed between a radiation source and a radiosensitive target, designed to absorb the radiation before it reaches the target. A simple example is a patient wearing a lead apron over his or her vital organs, while being exposed to X-rays at a hospital. In space, passive radiation shielding is more complicated than it sounds, because the variations in particle composition and energy spectra make it difficult to develop a catchall shield. For long-term, human-rated missions, the best material choices for passive radiation shielding tend to be multipurpose, hydrogen-rich, and have a small atomic mass. The purpose of this research is to investigate innovative passive shielding methodologies that are integrated into the design of space habitats. Specifically, this research will evaluate the feasibility of using multilayer materials, water walls, and varied habitat configurations in order to help keep astronaut radiation exposure as low as reasonably achievable. The goal is to improve the shielding efficacy against GCRs, while reducing the amount of parasitic mass required to protect the astronauts. NASA's On-Line Tool for the Assessment of Radiation in Space (OLTARIS) will be used to perform the analyses. This research directly serves to advance the fidelity of topic 6.5.3.2 in the 2015 NASA Technology Roadmap, and ultimately, it aims to advance our ability to explore our solar system.

Anticipated Benefits

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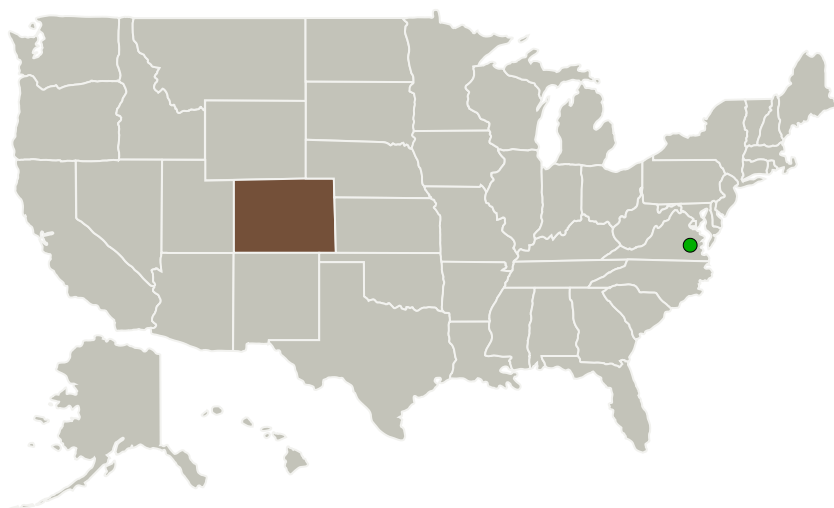
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parasitic mass required to protect the astronauts.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Colorado Boulder	Lead Organization	Academia	Boulder, Colorado
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations

Colorado

Project Website:

<https://www.nasa.gov/strg#.VQb6T0jJzyE>

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Colorado Boulder

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

James Nabity

Co-Investigator:

Daniel Case

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Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
 - └ TX06.5 Radiation
 - └ TX06.5.3 Protection Systems

Target Destinations

Earth, The Moon, Mars